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(54) Spread-spectrum communication apparatus

(57) A spread-spectrum communication apparatus includes a receiving antenna (1), amplifiers (2, 3, 6), band-pass filters (4, 8, 10), a threshold filter circuit (5), a despreader (9), a base-band demodulation circuit (11), and other circuit stages. The threshold filter circuit (5) is connected in series before the despreader (9). The threshold filter circuit (5) has a frequency-band width covering the band width of a spread signal and cuts interference waves at certain levels at each frequency within the frequency band. The threshold filter (5) circuit includes a magnetostatic wave device (7).

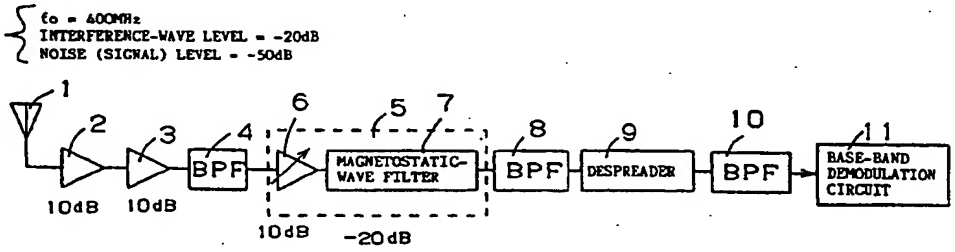

FIG. 1

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despreading is further improved. With this configuration, it is not required to match the frequency of the magnetostatic-wave filter with that of the despreader. Thus, any magnetostatic-wave filter and any despreader which are usable at various frequencies can be used. In addition, with the use of a frequency conversion circuit, the magnetostatic-wave filter can be used at high frequencies, at which the filter has superior saturation characteristics.

Other features and advantages of the present invention will become apparent from the following description of embodiments of the invention which refers to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a circuit block diagram of a spread-spectrum communication apparatus according to a first embodiment of the present invention.

Fig. 2 is a circuit block diagram of a spread-spectrum communication apparatus according to a second embodiment of the present invention.

Fig. 3 is a saturation characteristic chart of a magnetostatic-wave filter used in the present invention.

Fig. 4 is a chart indicating the levels of an interference wave and a noise signal at an antenna-receiving stage in the first embodiment of the present invention.

Fig. 5 is a chart indicating the levels of the interference wave and the noise signal after a threshold filter in the first embodiment of the present invention.

Fig. 6 is a chart indicating the levels of the interference wave and the noise signal after despreading in the first embodiment of the present invention.

Fig. 7 is a chart indicating levels after despreading in a conventional case where a threshold filter is not used.

Fig. 8 is a chart indicating the levels of an interference wave and a noise signal at an antenna-receiving stage in the second embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Embodiments of the present invention will be described below by referring to the drawings.

Fig. 1 is a circuit block diagram of a spread-spectrum communication apparatus according to a first embodiment of the present invention. In Fig. 1, there is shown a receiving antenna 1 and wide-band amplifiers 2 and 3, each having a power gain of 10 dB. A band-pass filter (BPF) 4 has a transmission band of at least 370 MHz to 430 MHz, which corresponds to the frequency band of a spread-spectrum signal. A threshold filter circuit 5 has a frequency band width covering the spectrum-signal band width and reduces interference waves having a certain level or more. It includes an AGC amplifier 6 and a magnetostatic-wave filter 7.

The magnetostatic-wave filter 7 is saturated at an input level of -20 dB at each frequency and hence removes input power existing at more than that level, as shown in Fig. 3. A signal sustains a loss of -10 dB when it passes through the magnetostatic-wave filter.

The AGC amplifier 6 connected in series before the magnetostatic-wave filter 7 amplifies (a gain of 10 dB in this case) the level of a signal until the output of the magnetostatic-wave filter 7 is saturated. A band-pass filter (BPF) 8 functionally operates in the same way as the band-pass filter (BPF) 4. A despreader 9 is made up of a matched filter, for example, and corresponds to [6, 1] in a pseudo-noise-code m series having a code length of 63. A band-pass filter (BPF) 10 shapes a signal demodulated by the despreader 9. A base-band demodulation circuit 11 recovers a signal by conventional AM detection, FM detection, phase detection, or the like.

Operation of the circuit according to the present embodiment will be described below. As shown in Fig. 4, an interference wave having a center frequency of 405 MHz is superimposed on a spread-spectrum wave having a center frequency of 400 MHz and a spread-signal band of 370 MHz to 430 MHz. The interference wave has a level of -20 dBm. The spread signal has a level equal to or less than a noise level of -50 dBm. When the wave in which the spread-spectrum radio wave and the interference wave are mixed is received by the receiving antenna 1, it is amplified by the wide-band amplifiers 2 and 3, each having a gain of 10 dB, passes through the band-pass filter 4, and is input to the threshold filter circuit 5.

When the mixed wave passes through the AGC amplifier 6 having a gain of 10 dB, the level of the interference wave becomes 10 dBm and the noise level becomes -20 dBm. The mixed wave, which has been amplified by a total of 30 dBm after it was input into the antenna, is input to the magnetostatic-wave filter. The filter has the saturation characteristics shown in Fig. 3 at each frequency. The output level is saturated when the input level reaches about -20 dBm. With a loss of -10 dB due to passing-through being considered, the saturated output level is nearly -30 dBm. Therefore, the mixed wave has the level shown in Fig. 5 after the wave passes through the magnetostatic-wave filter 7 (threshold filter 5). The maximum level of the mixed wave, which includes the levels of the interference wave and noise (including the spread signal), is -30 dBm.

quency of a signal output from said magnetostatic wave device (27) before the signal is processed in said despreader (9).

7. A spread spectrum communicating apparatus according to Claim 6, wherein said frequency converter (31, 32, 33, 8) includes a mixer (32) and at least one amplifier (31, 33) connected in series.

8. A spread spectrum communicating apparatus according to Claim 7, wherein said frequency converter includes a mixer and a pair of amplifiers connected in series.

9. A spread spectrum communicating apparatus according to Claim 8, wherein said mixer (32) is connected in series between said pair of amplifiers (31, 33).

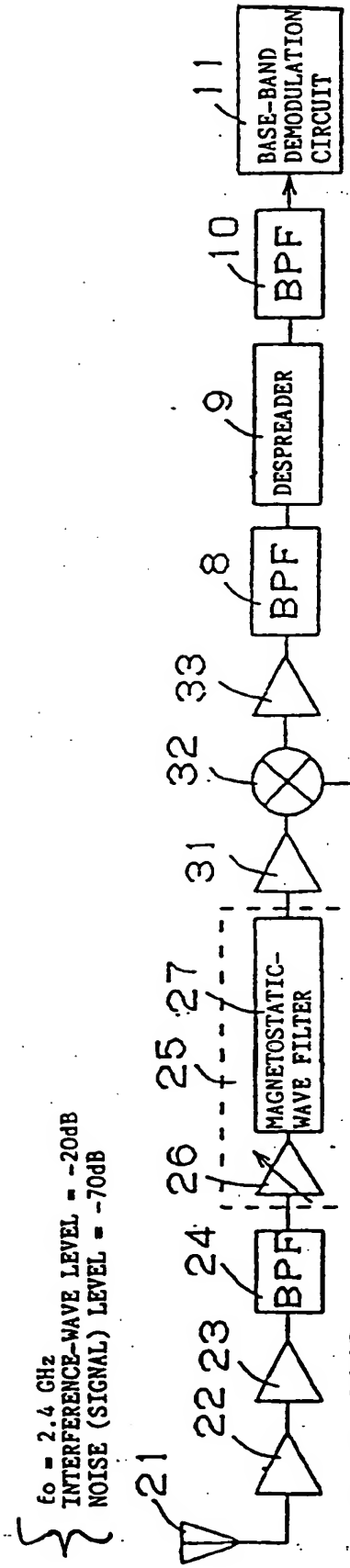
fo = 2.4 GHz
INTERFERENCE-WAVE LEVEL = -20dB
NOISE (SIGNAL) LEVEL = -70dB
21
22
23
24
BPF
20dB
20dB
20dB
26
25
27
MAGNETOSTATIC-WAVE FILTER
10dB
-20dB
20dB
31
32
33
20dB
fLo=2.8GHz
-10dB
8
BPF
9
DESPREADER
10
BPF
11
BASE-BAND DEMODULATION CIRCUIT

FIG. 2

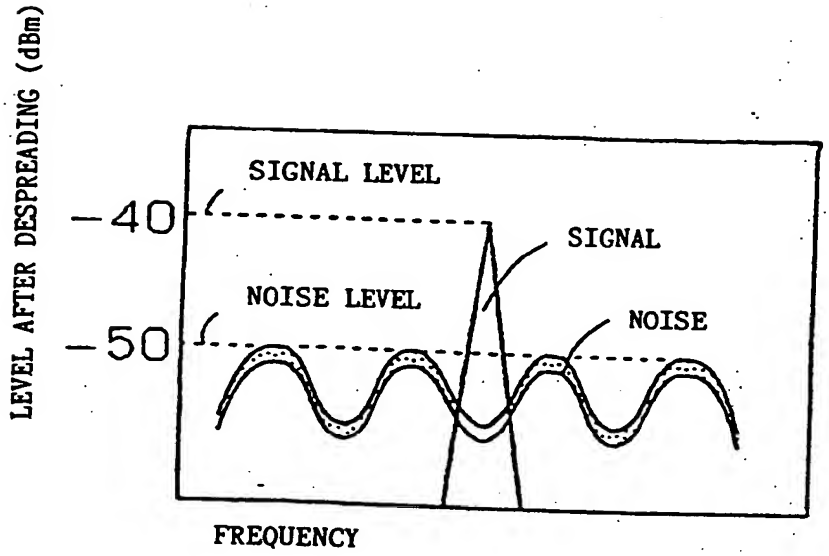

FIG. 6

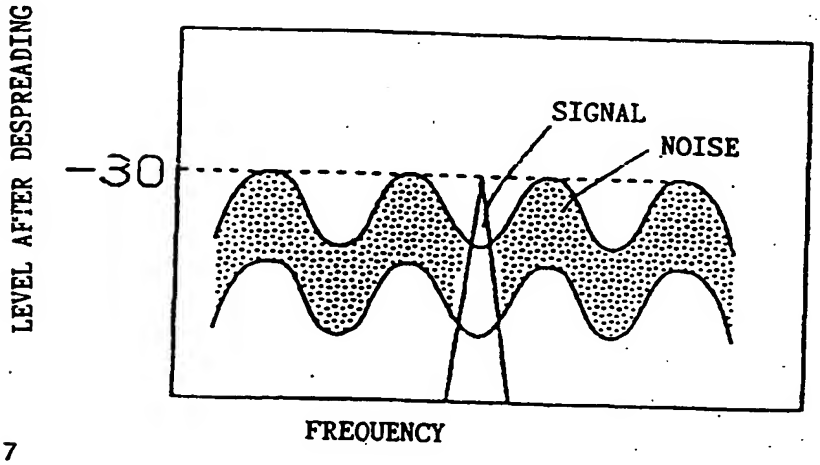

FIG. 7

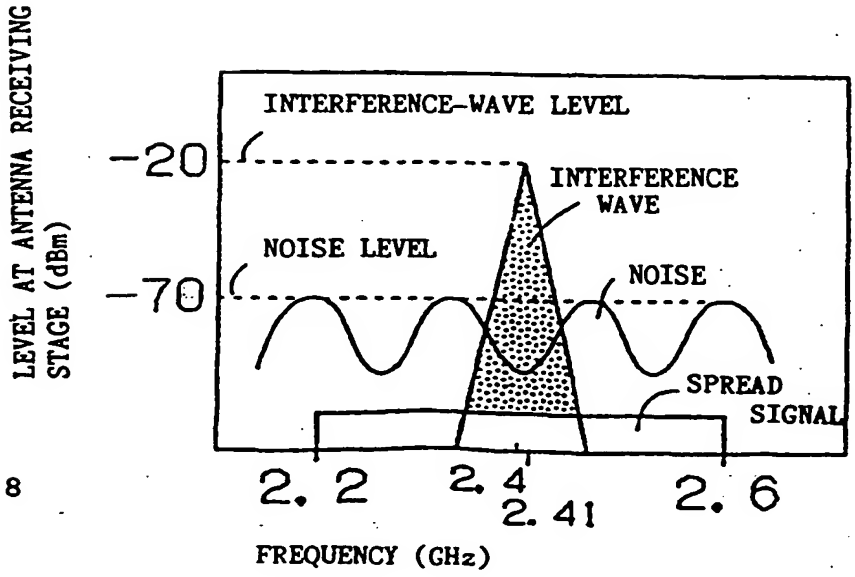

FIG. 8